US-PAT-NO: 4948397

DOCUMENT-IDENTIFIER: US 4948397 A

TITLE: Method, means and device for separation of particulate matter from a carrier medium

---------- KWIC ---------

Wet collectors, scrubbers: Liquid, generally water, is used to combine with the particles of the carrier medium to make the particles grow, increase in size, agglomerate and be collected. Interception and impingement are the predominant mechanisms in wet scrubbers. Equipments like spray towers, packed towers, impingement plate towers with medium energy consumption, are effective for medium size (5-10 microns) particle, give reasonable efficiency (-95%) with medium pressure drop (25-150 mm, 1-6" water column) and water consumption (up to water 3 ltr/m.sup.3). The high efficiency venturi scrubber imparts high velocity to the carrier medium by a converging cone and inject water at low pressure. Water, liquid, combines with the particles. The collection efficiency is high (order of 99%). However, the energy consumption is very high as pressure drops (up to 1750 mm, 70 inches water column), besides, particle wetting characteristics, condensation of moisture and drop evaporation, operating temperature are some of the features which affect the collection and limit viable application and creates the added problem of waste liquid handling.

Filtering: Particulate matter is entrapped by inertia, impingment, diffusion, interception and in certain cases by electrostatic force in a filter media, like woven fabric, or felt cloth, paper, fibrous mat, aggregate beds made up of materials like cotton, wool, nylon, dacron or other synthetic materials and blends, glass filter, metal, carbon and mineral fibre. When operating within permissible working conditions like fibre temperature, humidity, moisture, particle abrasion, particle loading, chemical composition and operating cycles the entrappment efficiency is high. However, filtering requires large filter surface area, due to low ratio of stream volume flow capacity to filter area and high energy, in the form of pressure drop across the filter to overcome the filter resistance. Moreover, the particulate matter entrapped on the filter accumulates and builds up forming a layer of deposit. The periodical removal of the deposit becomes essential to maintain the pressure drop (up to 150 mm, 6

inches water column) and the consequential energy consumption within practical operating levels so as to avoid physical damage to the filter media. The deposit is removed by the usual procedures like mechanical rapping, vigorus shaking, air or gas reverse jet flow, washing technique (reverse jet causes problems like fatige failure and clogging or media). The process, besides some of the earlier mentioned application constraints, has the drawback of being intermittent in nature, i.e., non-continuous in respect of any one filter area thus requires alternative filter for the cleaning, reverse jet cycle operation, requiring large space requirement and high and variable energy consumption due to varying pressure drop.

US-PAT-NO: 6368567

DOCUMENT-IDENTIFIER: US 6368567 B2

TITLE: Point-of-use exhaust by-product reactor

---------- KWIC ---------

Many of the films used in electronic device fabrication today are formed in deposition reactors similar to reactor 100 shown in FIG. 1. In deposition reactor 100, lamps 105 provide radiant heat to wafer 110 which is supported within reactor 100 by rotating susceptor 115. Process and cleaning gases are provided via gas inlet conduit 120 and inlet manifold 125. Gases are exhausted via exhaust manifold 130 and exhaust conduit 135. Exhaust conduit 135 is in communication with reactor 100 and the remaining exhaust systems 140 located within the wafer fabrication facility. Exhaust systems 140 may contain scrubbers, filtration units as well as other exhaust treatment systems.

During the cleaning process, cleaning gases are introduced into reactor 100 to remove unwanted deposits from internal reactor components. As these deposits are removed from reactor 100 and are exhausted via exhaust manifold 130 into exhaust conduit 135, the unwanted deposit/cleaning gas mixture can behave similarly to the unreacted source gas. Within Zone A, a portion of the unwanted deposit/cleaning gas mixture remains gaseous, does not form deposits, condense or polymerize on the interior walls of exhaust conduit 135. As a result of the higher temperatures used during cleans, temperatures within Zone A and some of Zone B will be high enough such that a portion of the unreacted cleaning gas exhausting from reactor 100 will remain active. Thus, within that region where the unreacted cleaning gas remains active, the unreacted cleaning gas will be able to react with and remove by-products 145 deposited within that active cleaning gas area of conduit 135.

US-PAT-NO: 6047713

DOCUMENT-IDENTIFIER: US 6047713 A

TITLE: Method for cleaning a throttle valve

---------- KWIC ---------

The exhaust flow control apparatus 30 shown in FIG. 1B is shown here as throttle valve 32 and shut-off valve 34 connected and in fluid communication with pump 72 such that the exhaust gas mixture from vacuum deposition chamber 10 is fed into a scrubber 74 for treatment. Throttle valve 32 is placed in close proximity to the chamber so that the plasma cleaning gas will reach the throttle valve and clean deposited material from the throttle valve surface.

flowing at least one cleaning gas into said vacuum chamber at a temperature and pressure in contact with said throttle valve for a length of time such that said unwanted film deposition is removed from said throttle valve.

27. A method of cleaning unwanted film deposition from a throttle valve mounted on a vacuum chamber for regulating gas pressure in said chamber by positioning said throttle valve juxtaposed to the vacuum chamber, forming a plasma in at least one cleaning gas and flowing the plasma into said vacuum chamber and contacting said throttle valve such that the unwanted film deposition is removed from the valve.

US-PAT-NO: 5443022

DOCUMENT-IDENTIFIER: US 5443022 A

TITLE: Fluidized bed reactor and method utilizing refuse derived fuel

---------- KWIC ---------

It is a still further object of the present invention to provide a reactor and method of the above type in which a dry flue gas scrubber treats the flue gas to lower the quantity of acid gases in the flue gas, and a fabric filter baghouse is provided which reduces the quantity of particulate materials in the flue gas to prepare the flue gas for disposal or discharge.

Toward the fulfillment of these and other objects, the fluidized bed reactor of the present invention includes a fluidized furnace section and stripper/cooler section. A downwardly sloping grid extends across the furnace section and the stripper/cooler section to a drain in the stripper/cooler section, and directional nozzles disposed in the grid fluidize the beds in the furnace section and stripper/cooler section and forcibly convey large particulate material across the grid, through the furnace section and stripper/cooler section, and to the drain for disposal. A refractory layer is provided along the grid surface to reduce the height of the nozzles within the furnace section, thereby helping to prevent relatively large particulate material from becoming entangled with, or stuck to, the nozzles. The furnace section and stripper/cooler section are designed to provide a relatively straight path for the large particulate material passing from the furnace section, to the stripper/cooler section, and to the drain. The furnace section is operated using two-staged combustion to lower, among other things, NO.sub.x emissions. The stripper/cooler section is operated in a batch mode to flush large particulate material from the furnace section and stripper/cooler section. A separator, steam generator tube bank, heat recovery area, dry flue gas scrubber, and fabric filter baghouse are used in combination with the furnace section and stripper/cooler section to provide for further combustion efficiency and pollution control and to prepare the flue gas for discharge.

A conduit 98 (FIG. 1) connects the separator 16 to a heat recovery area 100 for passing the separated flue gas from the separator 16 to the heat recovery area 100. A steam generator tube bank shown in general by the number 102 is

provided for cooling flue gas passing from the separator 16 to the heat recovery area 100. The steam generator tube bank 102 includes a steam drum 104, a plurality of cooling tubes 106, and a plurality of headers 108. The cooling tubes 106 extend downwardly from the steam drum 104 and through holes provided in the top walls of the conduit 98 so that the cooling tubes 106 extend in the path of the flue gas passing through the conduit 98. The headers 108 are disposed below the conduit in a hopper 109 connected to the conduit 98 and extending below the tubes 106 and headers 108. The headers 108 are sized to permit debris and deposits to be removed therefrom using mechanical rappers (not shown) which strike the ends of the headers 108 and thereby induce vibrations of the headers 108 and the tubes 106. Flexible feeders (not shown) connect the headers 108 to downcomers (not shown) which are in turn connected to other portions of the fluid flow circuitry of the reactor 10.

A dry flue gas scrubber 112 is connected to the heat recovery area 100 for receiving the cooled flue gas and neutralizing acid components of the flue gas, such as sulfur dioxides, hydrochloric acid, and hydrofluoric acid. A fabric filter baghouse 114 is connected to the scrubber 112 for removing particulate material remaining in the flue gas, such as flyash, scrubber reaction products, and unreacted lime (introduced in the scrubber 112 as will be described). The baghouse 114 is connected to a stack 116 for disposal or discharge of the treated flue gas into the atmosphere.

The cooled flue gas exits the heat recovery area 100 and passes to the dry flue gas scrubber 112. A lime slurry is atomized and injected into the scrubber 112 to neutralize acid gas components of the flue gas (primarily sulphur dioxides, hydrochloric acid, and hydrofluoric acid). The water in the slurry is evaporated by the hot flue gas producing dry powder reaction products. Additionally, small qualities of activated carbon are mixed with the lime slurry and sprayed into the scrubber 112 to further lower emissions of certain trace heavy metals, dioxins, and organic compounds. The treated and cooled flue gas then exits the scrubber 112 at approximately 275.degree. F. and passes to the fabric filter baghouse 114.

In the baghouse 114, the remaining particulate material, consisting primarily of flyash, dry scrubber reaction products, and unreacted lime, is collected on an array of fabric filter bags as contained in multiple modular units. Collected material is periodically removed from the bags using pulses of compressed air flowing in reverse to the normal flue gas flow.

US-PAT-NO: 5389127

DOCUMENT-IDENTIFIER: US 5389127 A

TITLE: Method of cleaning a drop separator and drop separator with cleaning device

---------- KWIC ---------

Downstream of any gas scrubber generally a drop separator is provided in a first scrubber of a two-stage gas scrubbing installation, e.g. for the cleaning of flue gas, with a first scrubber for the removal of dust and optionally of HCl and a second scrubber for SO.sub.2 removal.

Particularly in the case of flue gases with a high proportion of fly ash, such as, for instance, downstream from an older electrofilter, the cleaning performed by this nozzle arrangement is not satisfactory. The drop separator clogs easily which results in frequent standstills, while the deposits are removed, for instance, by water under high pressure or by compressed air. In the worst cases the drop separator has to be replaced.

A drop separator with horizontal flow, as shown in FIG. 1 is arranged in the flue gas channel between a first and a second scrubber of a gas scrubbing installation, has a four-tier separating device covering the cross section of the gas channel, whereby in each tier five blade packets 1 are arranged next to each other. The blade packets 1 are supported on carriers 2 arranged between the blade packets 1 and running perpendicularly downward, through all tiers. Underneath the blade packets 1, there are water collecting tanks 3 and in their middle profiles 4, whereby the water collecting tanks 3 abut the profiles 4 of the blade packets 1 arranged therebelow.

A drop separator with vertical flow as shown in FIG. 5 is arranged optionally downstream of a counter-flow scrubber of flue gas scrubbing installation.

US-PAT-NO: 5306350

DOCUMENT-IDENTIFIER: US 5306350 A

TITLE: Methods for cleaning apparatus using compressed fluids

---------- KWIC ---------

Another method is disclosed in U.S. Pat. No. 4,238,244, issued Dec. 9, 1980, which uses the technique of raising and lowering pressure to produce gas bubbles for removing inorganic deposits from industrial equipment such as heat exchangers. It is different from the above discussed methods in that it generally circulates the cleaning liquid through the apparatus. The method disclosed is specifically the removal of deposits of corrosion products and scale from the interior surfaces of heat transfer equipment with a liquid composition capable of removing said deposits under appropriate contact conditions of pH, temperature, concentration, and pressure for a period of time sufficient to remove the deposits. The deposits cited to be removed include inorganic materials such as metal oxides, spinels, metal sulfides, and water scale such as gypsum and magnesium oxides and others. The liquid cleaning compositions cited for removing the deposits include inorganic and organic acids, salts of such acids, and inorganic and organic bases. The method generally calls for dissolving at super atmospheric pressure a chemical that is a gas at atmospheric conditions to form a solution that produces a gas when at reduced pressure. The preferred gas is carbon dioxide. The procedure comprises: contacting the deposits with the solution for an initial period of time; contacting the deposits with this solution for an additional period of time at a reduced pressure, wherein carbon dioxide is liberated from the solution and said solution is therein agitated during such said contacting; and repeatedly raising and lowering the pressure exerted on the solution while contacting the deposits such that carbon dioxide is repeatedly placed in solution and liberated therefrom, thereby causing agitation which improves the deposit removal. The super atmospheric pressure mentioned ranges from above atmospheric up to about 1500 psig at temperatures in the range of from atmospheric to about 350 F. (about 177 C.). While it is indicated that various concentrations of the gas-forming substance can be used, it is asserted that concentrations in the range from about 0.1 percent to about 5 percent by weight of deposit-removing liquid has been found to be effective. The deposit-removing liquid that consists of acids, bases, or salts constitute a

significant majority of the combined deposit-removing, liquid-gas-forming admixture. Whereas such a method enhances the removal of inorganic deposits and scale, it does not significantly result in a reduction in the use of the deposit removal cleaning solution. In addition, this method practices the fluctuation of temperature and pressure condition repetitiously to provide the improvement cited, which is related to formation of gas bubbles which provide the agitating force. Practicing said method would generally suggest the necessity of utilizing an intricate monitoring, control, and operating process for the method to be effective and practical. Such devices are costly and would add to the overall capital, period, and operating costs. Furthermore, the highly corrosive cleaning solution that consists of acids, bases, or salts employed for removing the inorganic deposits is inappropriate and incompatible with removing organic deposits such as coating formulation and polymers from spray apparatus.

In the methods of the present invention, wherein spray apparatus is purged and cleaned between coating material change or at shut down, organic solvents constitute not only part of the coating formulation but the cleaning solution as well. Since these organic solvents generally are potential pollutants, their containment and waste disposal dictate minimal usage. Such would not be the case if the method discussed in the aforementioned patent was practiced within the constraint implied by the very low range of concentration of the gas-forming substance in the deposit-removing liquid. Moreover, with coating formulations admixed with supercritical fluids such as carbon dioxide as diluents, lowering the pressure to levels below the critical point could result in the formation of two phases plus significant vaporization of carbon dioxide, wherein pockets high in carbon dioxide concentration may form and contact the coating admixture, from which could result undesirable deposition of coating materials on conduit walls and on internal surfaces of the apparatus, which causes deposits that are harder to remove. In fact, under the worse of conditions, highly viscous pure, or nearly pure, polymer could come out of solution, indeed presenting a most difficult and costly removal condition.

Moreover, the compressed fluid is preferably environmentally compatible, can be made environmentally compatible by treatment, or can be readily recovered from the spray environment. For example, carbon dioxide is environmentally compatible. Nitrous oxide can be made environmentally compatible by natural decomposition in the environment, or by heating to thermally decompose it, to form molecular nitrogen and oxygen. Ethane and propane can be made environmentally compatible by incineration to carbon dioxide and water. Ammonia is highly soluble in water and can be removed and recovered from air streams by absorption methods such as an air/water scrubber. Other methods can also be used such as adsorption.

US-PAT-NO: 5092766

DOCUMENT-IDENTIFIER: US 5092766 A

TITLE: Pulse combustion method and pulse combustor

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In a further embodiment of this type pulse combustor, the downstream end of the space is closed and a nozzle slanting downward to the downstream direction is connected at the lower part of the downstream end of the space. The nozzle acts as a deposit removing means. When the compressed gas is discharged through the nozzle, it blows substance deposited in the dryer, in which the pulse combustor is incorporated, and further ejects the substance from the dryer.

In an embodiment mentioned in FIG. 1, compressed air is used as the compressed gas. The pulse combustion drying apparatus comprises a pulse combustor 1, a dryer 10 disposed on the same axis as the pulse combustor 1 and enclosing the pulse combustor 1, a product collector 20 attached to the downstream site of the dryer 10, a scrubber 31 connected to the product collector 20 through a duct 30, a fuel supply device 40 and a substance supply device 50.

The duct 30 connects the collector 20 with the scrubber 31. The one end of the duct 30 is connected to an upper part of the cylindrical part 21 of the collector 20 at the opposite side of the connecting place of the cylindrical part 21 and the dryer 10, and the other end is connected to a lower part of the scrubber 31.

The scrubber 31 comprises a vertical cylindrical part 32, a fan part 33 fixed on the outer wall, a muffler 35 connected with the cylindrical part 32 through a pipe 34, a slurry tank 36 disposed below the cylindrical part 32 and a circulating water pump 66. The fan part 33 has a function of reducing the pressure in the scrubber 31 and further reducing the pressure in the whole drying apparatus. The circulating water pump 66 supplies water 38 deposited in the slurry tank 36 of the scrubber 31 for the upper cylindrical part 32 of the scrubber 31 again. A water pipe 82a connects the slurry tank 36 to the water inlet of the pump 66, and a water pipe 82b connects the water outlet of the pump 66 to the fan part 33 of the scrubber 31. U A fuel pipe 42, which has a

valve 41, connects the fuel supply device 40 with the combustion chamber 2 of the combustor 1. The fuel pipe 42 pierces through the wall of the dryer 10 and leads to the combustion chamber 2. Natural gas, propane gas, oil or the like may be used as fuel.

When the pulse combustion drying apparatus is started, environmental air is took into the dryer 10 through the muffler 11, and a gas and dust remained in the dryer 10 are discharged outside, as the fan part 33 of the scrubber 31 operates. This prevents poor combustion.

Most of the solid component discharged to the product collector 20 is collected in the lower part of the collector 20 because of the gravity, and only a part of the solid component which is relatively light moves with the combustion gas to the scrubber 31 through the duct 30. The dried substance collected in the collector 20 are discharged from the pulse combustion drying apparatus through the outlet 24 disposed at the bottom of the collector 20.

The light solid component and the combustion gas are separated in the scrubber 31, and the solid component is eliminated. Only the gas is transported through the elbow pipe 34 and the muffler 35 and then discharged. The solid component is discharged to a precipitator 37a of the slurry tank 37 disposed at the bottom of the scrubber 31. The clean water in the precipitator 37a overflows to a clean water tank 37b disposed next to the precipitator 37a, and the water is supplied for the fan part 33 of the scrubber 31 again through a circulating water pump 66.

US-PAT-NO: 4888158

DOCUMENT-IDENTIFIER: US 4888158 A

TITLE: Droplet impingement device

---------- KWIC ---------

Impingement separators are used in numerous industrial applications. In most cases the application is intended to remove all of the particulate in the gas stream. Examples include chevron type separators used in wet scrubbers to remove entrained slurry droplets, chevron separators used in steam drums to aid steam-water separation, and the I-beam separators used in circulating fluidized beds.

Accordingly, one aspect of the present invention is to provide an apparatus for separating unevaporated droplets from a hot gas stream comprising at least one row of a plurality of impingement members situated in a hot gas stream so that the gas stream passes therethrough, means for heating the impingement members to dry the impinging droplets thus forming deposits, and means for removing the deposits from the impingement members. The apparatus in its preferred embodiment has at least two rows of tubes vertically located in a plane normal to the gas stream in a staggered array.

A still further aspect of the present invention is to provide a method for separating unevaporated droplets from a hot gas stream, comprising the steps of: providing at least one row of a plurality of impingement members in a gas stream so that the gas stream passes therethrough; heating the impingement members to dry the impinging droplets so as to form friable deposits; and removing the deposits from the impingement members. In the preferred method of the present invention there are at least two rows of a plurality of impingement members arranged vertically in a plane normal to the gas stream in a staggered array.